Remarks

The Examiner has objected to the drawings as failing to comply with 37 CFR 1.84(p)(5) for failing to include certain reference signs and has required corrected drawing sheets. In responding to these objections and rejections, the Applicant submits replacement sheets 3/7 (with reference numeral 18) and 5/7 (with reference numeral 166 instead of 116). Reference numeral 150 on page 8, line 9 and on page 9, line 3 has been be changed to read "50", as is also shown in Fig. 5. Further changes in the description on pages 4, 7, 8, and 9 correct inaccuracies which can easily be understood in comparisen to the text and the drawings. Review and acceptance is requested.

Claims 4 and 6 stand rejected under 35 USC 103(a) as being unpatentable over Boulton '061 in view of Klien '202 and Heljkenskjold '767. The Examiner has, however, indicated that claim 5 is objected to as being dependent upon a rejected base claim but would be allowable if rewritten in independent form to include all the limitations of the base claim and any intervening claims.

The Applicant respectfully disagrees with the position taken by the Examiner for the following reasons.

The Examiner argues that it would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the honing apparatus of Boulton with an electromotor coaxially installed as taught by Klein et al. in order to provide a direct drive to bar 11 in order to make the grinding apparatus more compact, thus reducing

the footprint of the grinding apparatus, and further modified with a linear motor as taught by Keijkenskjöld, since Keijkenskjöld states in col. 2, lines 20 – 25, that such a modification would provide a machine that is very compact, thereby improving the rigidity and exactness of the machine (page 6/7 of the Official Action).

The Applicant respectfully disagrees. Boulton, when employing the machine in vertical arrangement of the spindle, teaches use of a hydraulic cylinder 69 as a counter-balance (col. 4, lines 46/47 and 55). This is just one conventional measure in such an arrangement with regard to the drive means for reciprocation of the spindle. Boulton is concerned with torque control during honing and improvement of the stone expansion system (col. 1, line 45/46). He does not deal with the processing of smaller bores having a diameter of only one or two millimetres at an increased rotational speed, which also requires a highly increased stroke speed (speed of the honing spindle in axial direction; see the present application, p. 2, lines 5 et seq.). Boulton therefore uses a rather slow driving mechanism for axial reciprocation of the spindle, namely a lead screw 9 driven by an electric motor 67 via a belt 61, and thus does not give any indication how to solve the problem in accordance with the invention of honing small bores.

This is emphasized by the fact, already noted by the Examiner, that Boulton also uses a motor ("wedge motor") 13 for displacing the bar, which serves to expand the honing stones 3 in radial direction, wherein the motor is <u>not</u> coaxially arranged with the spindle.

Klein is concerned with a new procedure for reducing burrs and grate-like sheet material particles generated and not removed in a preceding honing process and, by means of a particular brush, implements a process called "brush-honing" into a device, which operates similar to a honing device. In this procedural aspect, a means for expanding the brushes is used, wherein the drive motor for this purpose can actually be compact view of the comparably low pressure and accuracy needed for the brushes. Conventional drives (not described in detail) are recommended for axial displacement of the spindle (see col. 4, line 25 – 30). Thus, Klein also fails to suggest modification of a device like Boulton's with a linear electric motor for high stroke speed to hone small bores.

Keijkenskjöld discloses a special abrasive machine for simultaneously removing material from the plane-parallel opposed side surfaces of bearing rings (col. 1, lines 3 – 5). A first grinding disk 1 (see col. 1, line 35/36) is attached to tubular first shaft 5 and a second grinding disk 2 to a second shaft 7. The first shaft 5 carrying the first tool 1 is rotated by a conventional electric motor 11 (see col. 1, line 58), while the second shaft 7, with the second tool 2, is either non-rotated or rotated by the drive motor 11 via a driver that is not shown (see col. 2, line 21 and 26). Drive means 13, 14 (preferably "formed as linear motors"), do not serve to reciprocate the tools 1 and/or 2, but rather to vary the width of the gap between tools 1 and 2 (see col. 2, line 7). The housing 8, which is the actual tool-carrying member and thus, if at all, could be compared to the honing spindle of a honing device, is fixed and does not move at all. The linear motors 13, 14 are clearly used for a different purpose. Thus, Keijkenskjöld also fails to suggest a linear motor for use as a drive mechanism for reciprocating the tool in a honing operation.

In summary, there is no suggesting in these references to combine Boulton, Klein and Keijkenskjöld and modify them, which would still be necessary to a considerable extent, in order to arrive at the present invention.

As will be evidenced below, the honing device in accordance to the present invention **leads to a surprising advantageous effect in producing a product with improved qualities.** The following material is submitted as evidence thereof:

Annex A shows a conventional honing spindle having an electrical motor for driving the honing spindle, an electrical motor for feeding the tool expansion bar, and a hydraulic drive means incorporated in the machine stand to reciprocate the honing spindle.

Annex B1 – B5 show data obtained with the hydraulic honing device (conventional) in comparison with data obtained with a linear honing device in accordance to the invention.

B1 shows the **speed of the spindle (stroke speed, m/mim) vs. the stroke length (mm)** for both machine types. With a rather long stroke of 70.0 mm, the linear honing device was able to achieve a much higher stroke speed, namely 50.0 m/min, whereas the conventional hydraulic honing device could only achieve 24 m/min. In addition, the surprising result, however, is that with the linear honing device, rather small strokes for the treatment of very short borings 2.0 mm could be managed. **This was not at all possible until now.**

B2 shows a comparison of the **stroke quantity** (double strokes per minute) **vs. the stroke length** (mm) and demonstrates that – corresponding to the higher stroke speed – the same stroke length can be machined using the linear electric motor with remarkably higher stroke frequency, especially for short stroke lengths (2.0 mm). As already mentioned, this relationship is necessary to achieve the typical honing cross-grinding pattern. Even a stroke frequency of approximately 940 double strokes per minute can thus be achieved. **This is a sensational progress**, which leads to a remarkable decrease in the time needed for a particular workpiece.

The same follows from a comparison of the **average stroke speeds (B3)**, the achievable **accuracy in reversing the motion (B4), and noise level generated (B5).**

Annex C shows comparison photographs of the surface generated with hydraulic (conventional) units (the upper two pictures) and the surface generated with the linear honing device in accordance to the present invention (the lower two pictures). As indicated, the right hand pictures show the same surface with an enlarged scale. The cross-grinding-pattern generated with conventional hydraulic honing shows at irregular intervals straight lines forming rectangular patterns with respect to the axis of honing. They apparently result from the fact that the hydraulic feeding operation does not occur at a strictly steady state, but rather includes "mini"-stops, possibly caused by pressure irregularities in the hydraulic medium or by the pistons sticking to the seals, i. e. a sort of stuttering. As shown by the pictures in the lower half of enclosure C, the cross-grinding

pattern with a linear honing device shows a much more uniform pattern, i. e. it achieves not only advantages in the honing process, but also a **much superior product quality**.

It should be added that the synergy between the novel features of the invention (as compared to Boulton) results in a rather small and light-weight "back pack" construction for the overall unit, which can make full use of the qualities of the linear electric motor for the honing of small bores as e. g. used in nozzles, pumps and valves of fuel injection systems.

Based on these remarks it is clear that claim 4 recites elements which provide for a precision honing and grinding not achieved by conventional devices. Since none of the prior art of record suggests the particular combination claimed, nor provides motivation for the excellent results given by the combination claimed, the Applicant respectfully submits that claim 4 is sufficiently distinguished from the prior art of record to warrant patenting in the United States.

However, in order to facilitate prosecution of this Application, the Applcant has chosen to submit new claims 7 through 11. New claims 7 and 8 substantially correspond to the limitations of former dependent claim 6. Moreover, the Applicant has submitted new claim 9 which further clarifies the structural limitations achieved by the device in accordance with the invention, which are not possible in the machines of prior art. Further structural limitations are the subject of dependent claims 10 and 11. With regard to claim 9, the synergetic relationship between the first electric motor and the linear motor has been given additional physical content by requiring that the device be structured and dimensioned to generate the

stroke speeds and reversal accuracies claimed. The limitations of claims 10 and 11 specify a correlation between the rotational velocity generated by the electro motor and the linear velocity generated by the linear motor, since these two quantities cooperate to determine the cross grinding pattern angle as claimed.

The Applicant submits that the independent claims of record are sufficiently distinguished from the prior art of record to warrant patenting. The dependent claims of record inherit the limitations of the respective base claims and are therefore similarly distinguished from the prior art of record for the reasons given. Passage to issuance is therefore requested.

No new matter has been added in this amendment.

Respectfully submitted,

Paul Vincent

Dr. Paul Vincent

Registration number 37,461

June 03, 2006

Date

Enclosures:

New Figures 3 and 5

Annexes A, B1 through B5 and C

Dreiss, Fuhlendorf, Steimle & Becker

Patentanwälte

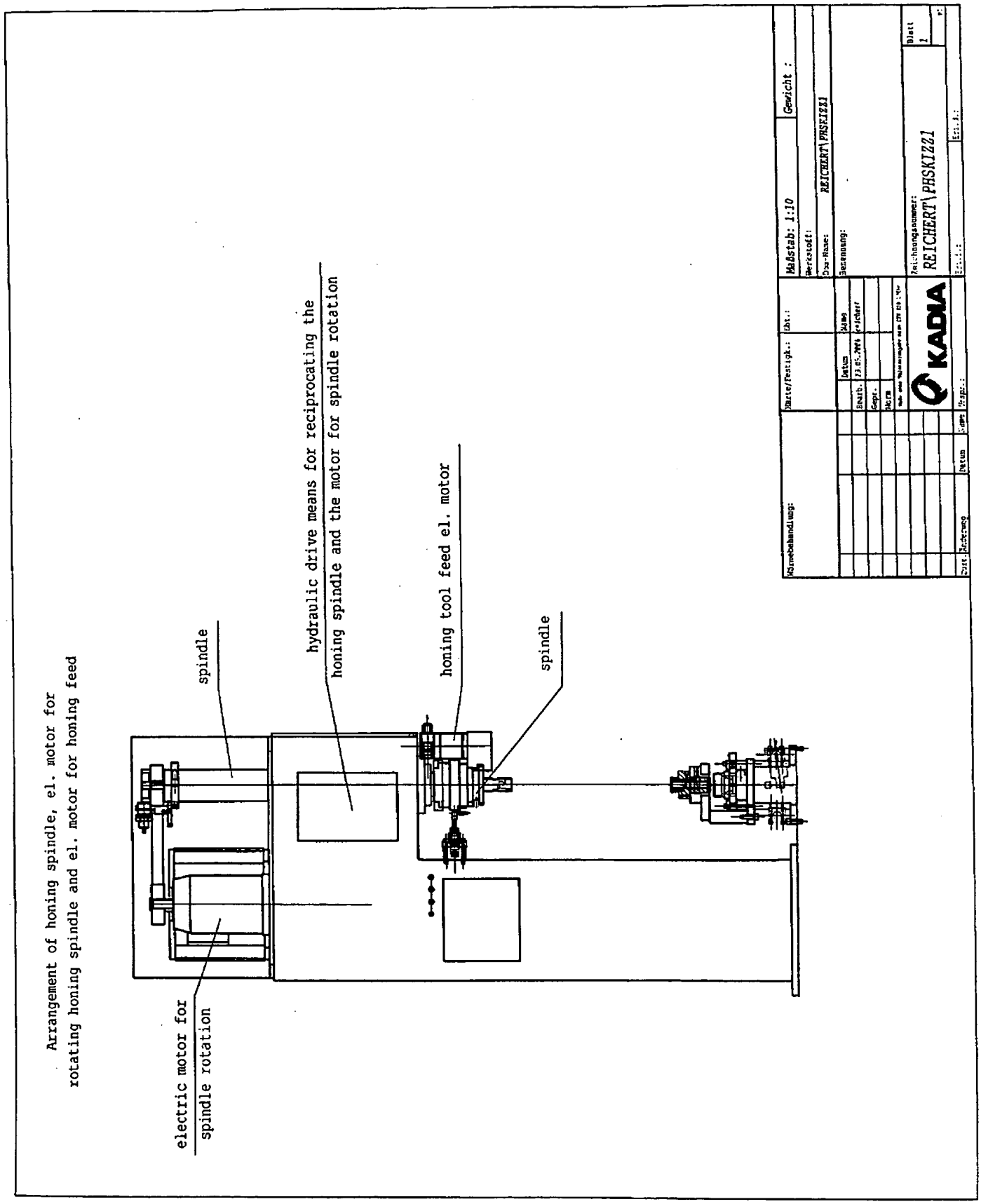
Postfach 10 37 62

D-70032 Stuttgart, Germany

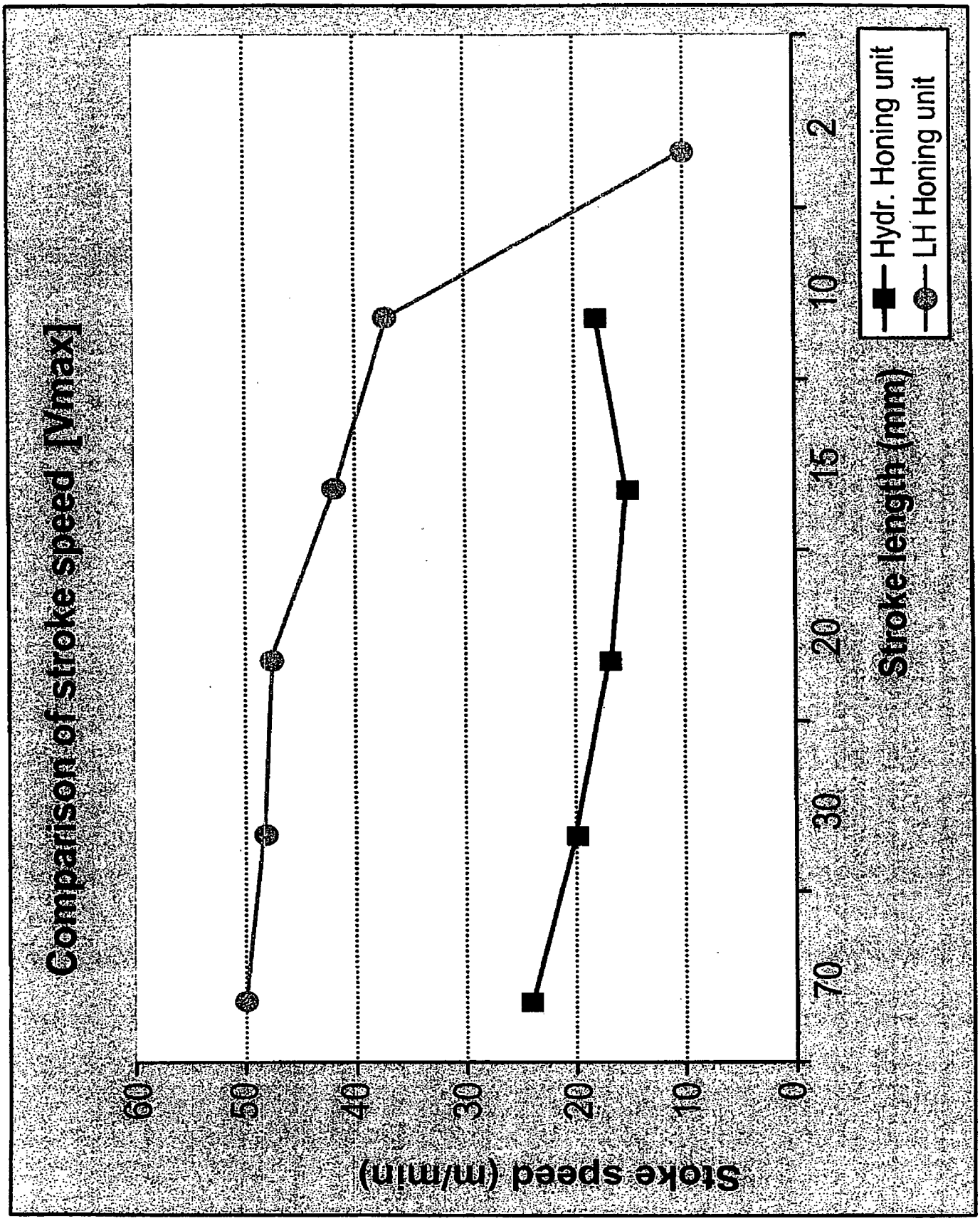
Telephone +49-711-24 89 38-0

Fax +49-711-24 89 38-99

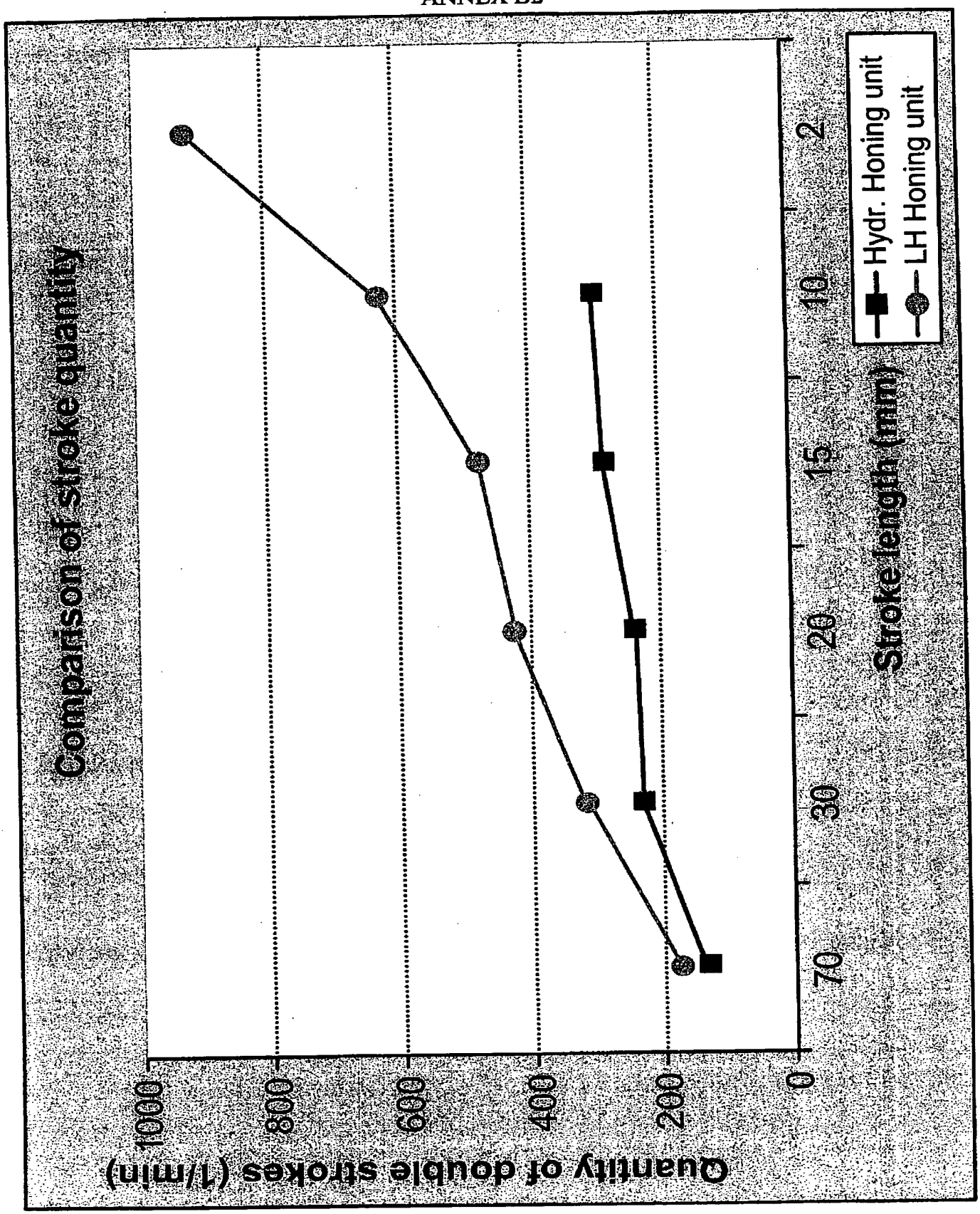
ANNEX A


Arrangement of honing spindle, el. motor for
rotating honing spindle and el. motor for honing feed
spindle
hydraulic drive means for reciprocating the
honing spindle and the motor for spindle rotation
honing tool feed el. motor
spindle
electric motor for
spindle rotation
KADIA
REICHERT\PHSK1221
Maßstab: 1:10
Gewicht :

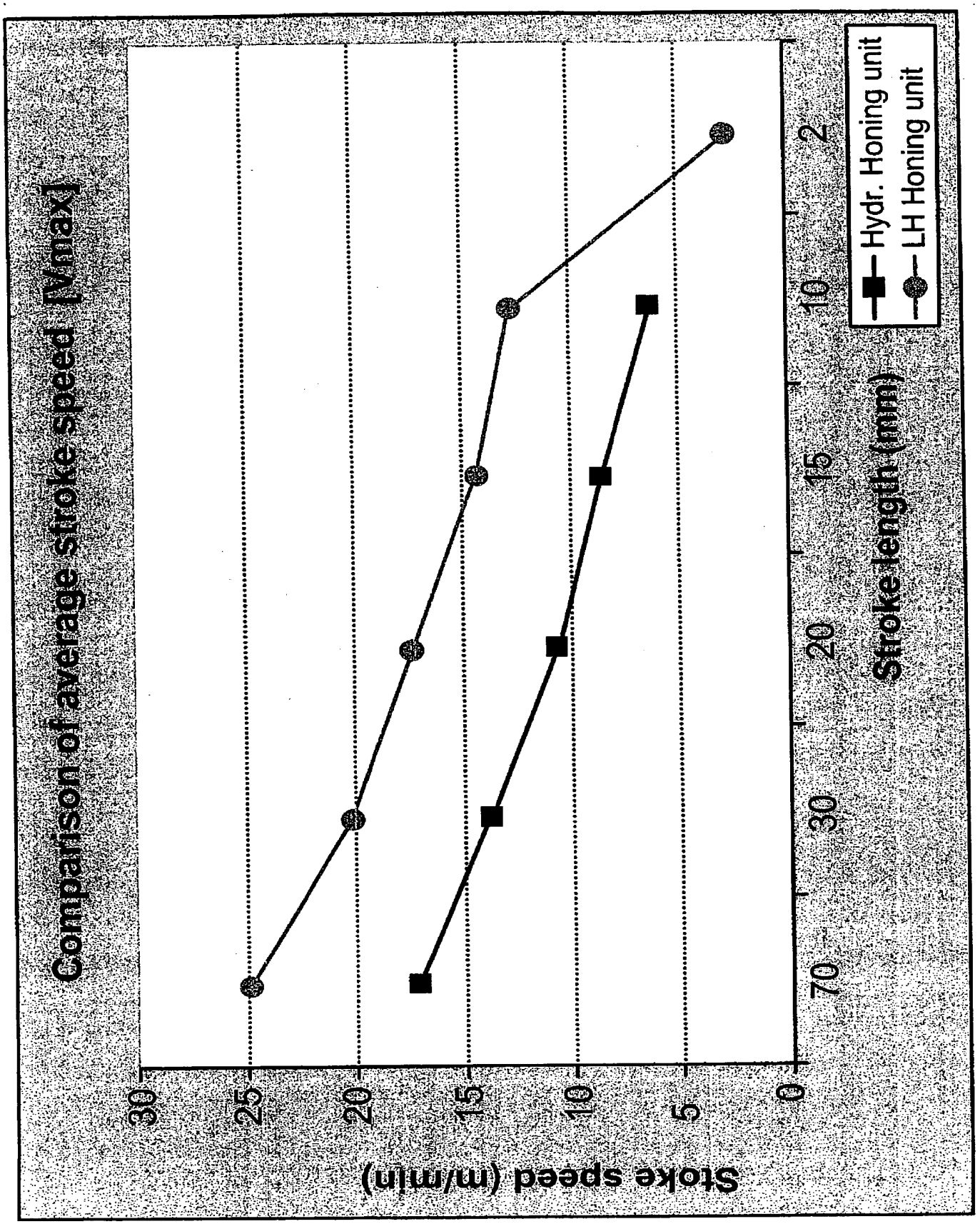
ANNEX B1


Comparison of stroke speed (Vmax)
Stroke speed (m/min)
0
10
20
30
40
50
60
Stroke length (mm)
2
10
15
20
30
70
Hydr. Honing unit
LH Honing unit

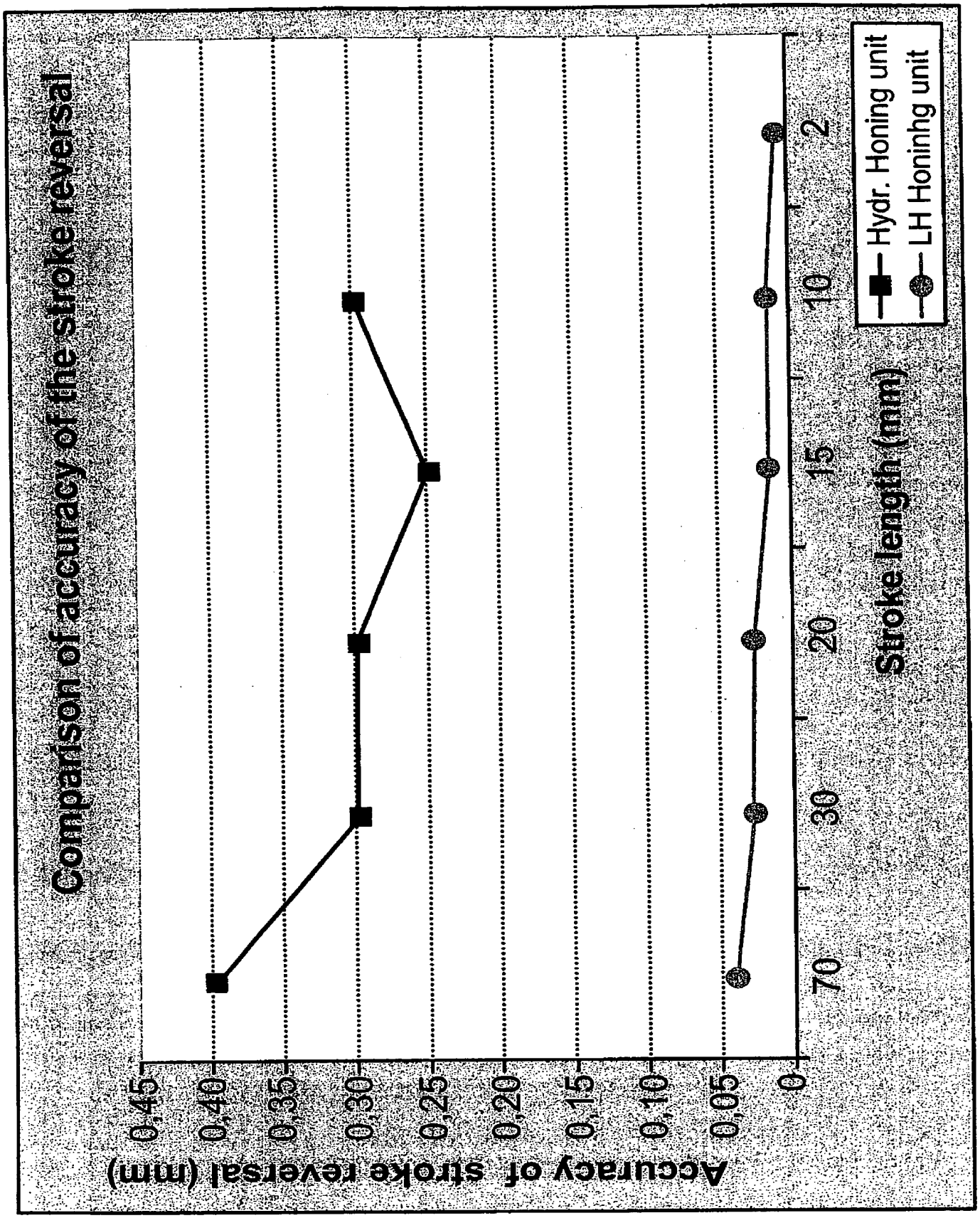
ANNEX B2


Comparison of stroke quantity
Quantity of double strokes (1/min)
1000
800
600
400
200
0
Stroke length (mm)
2
10
15
20
30
70
Hydr. Honing unit
LH Honing unit

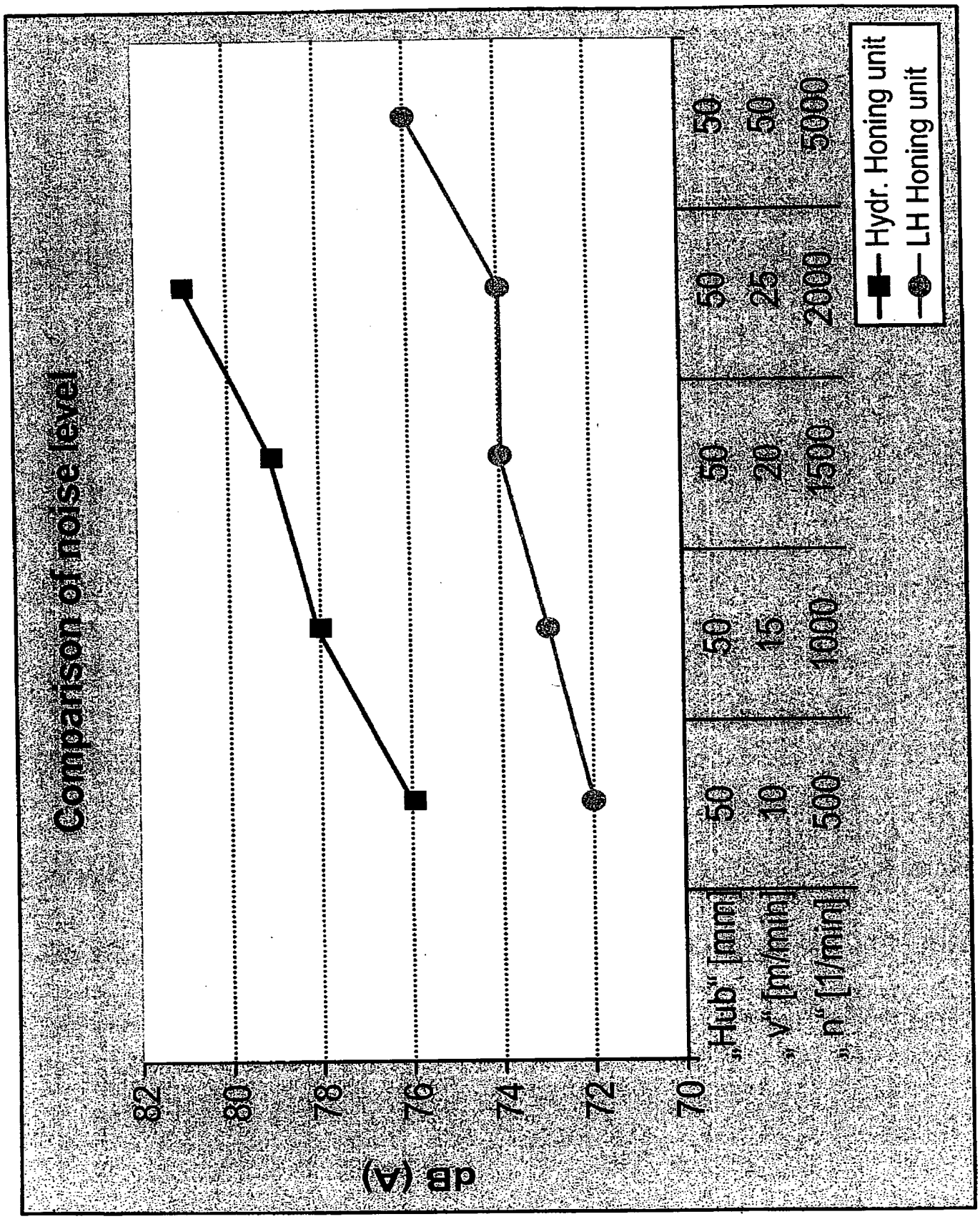
ANNEX B3


Comparison of average Stroke Speed [Vmax]
Stroke speed (m/min)
30
25
20
15
10
5
0
Stroke length (mm)
2
10
15
20
30
70
Hydr. Honing unit
LH Honing unit

ANNEX B4


Comparison of accuracy of the stroke reversal
Hydr. Honing unit
LH Honinhg unit
Stroke length (mm)
2
10
15
20
30
70
Accuracy of stroke reversal (mm)
0,45
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0

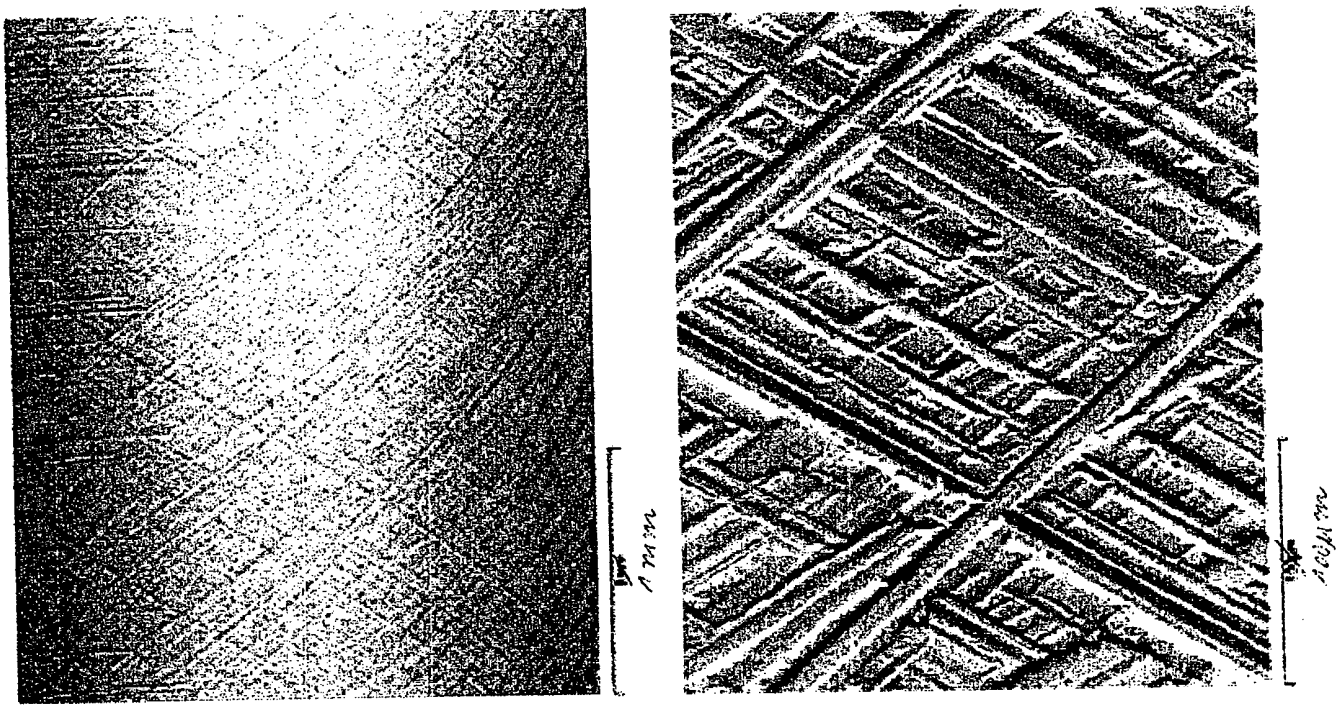
ANNEX B5


Comparison of noise level
dB (A)
82
80
78
76
74
72
70
„Hub" [mm]
„v" [m/min]
„n" [1/min]
50 50 50 50 50
10 15 20 25 50
500 1000 1500 2000 5000
Hydr. Honing unit
LH Honing unit

ANNEX C

Comparison of surface finish structure

Hydraulic honing unit



LH honing unit